A GIGANTIC "PLEASURING GROUND": THE YELLOWSTONE NATIONAL PARK OF THE UNITED STATES

II.

LEAVING the Yellowstone Basin, and crossing in a westerly direction the range which divides the drainage of the Yellowstone and the Madesin, we come into the great Geyser Basin of the Firehole river, a branch of the Madesin Forth. Travelling in this region is attended with great difficulties on account of the immense quantity of fallen timber. The uplands, as well as the lowlands, are covered with a dense growth of pines, the majority of which have a trunk not over 6 in. to 12 in. in diameter, but run up to a height of 100 ft. to 150 ft., as straight as an arrow. In crossing this shed the source of the east fork

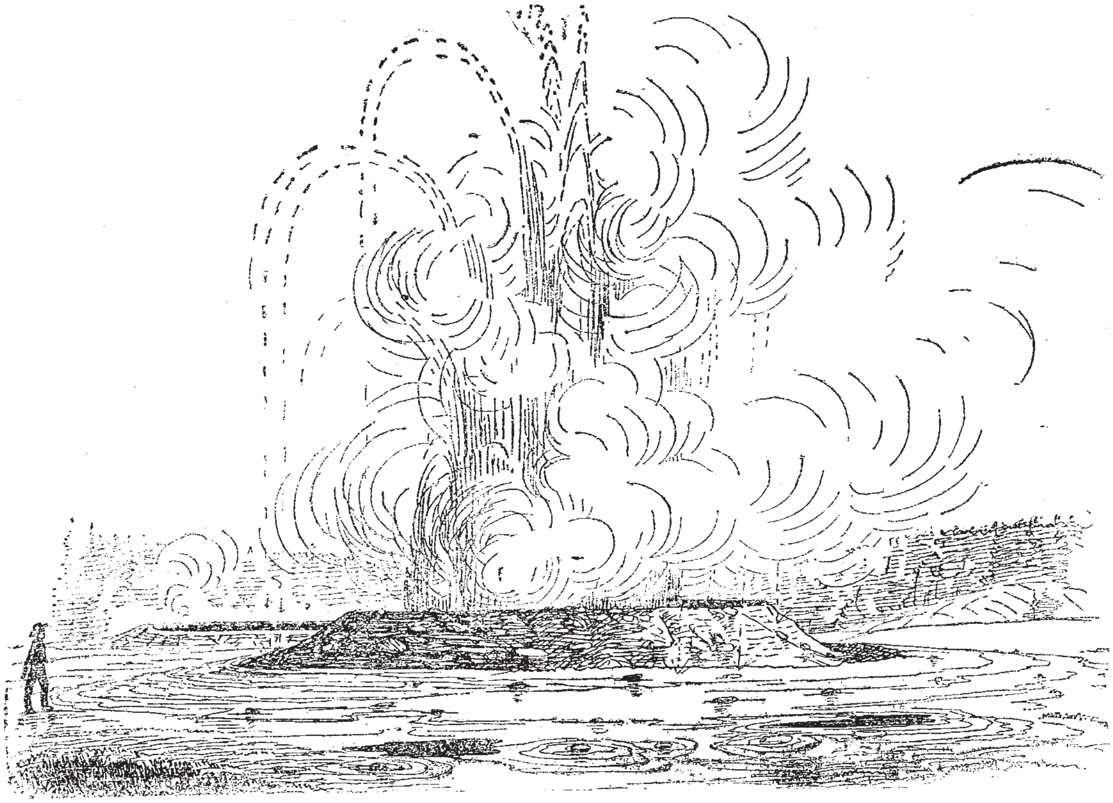

FIG. 5.—Architectural Fountain.

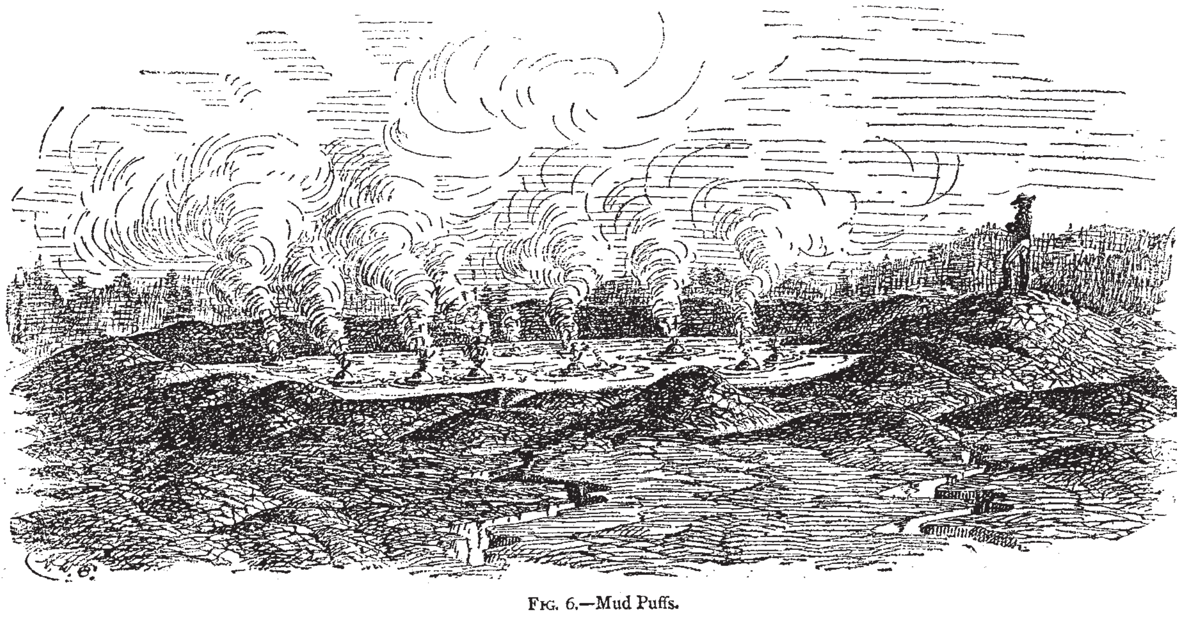

FIG. 6.—Mud Puffs.

of the Madesin is first struck, and every few miles a group of dead or dying springs is met with. In the distant view the appearance of the whole country may be not inaptly compared to a vast limekiln in full operation. The last branch of the Madesin is almost entirely fed by water from the hot-springs, and its temperature is 60° or 80° all the time. The vegetation that grows along the banks, and in the stream itself, is a marvel of luxuriance. The mountains that enclose the valley on either side are composed of basalt and obsidian. As we proceed down the valley, toward the junction of the east fork with the Madesin, the springs grow more abundant, and we soon come to the great basin of the Firehole, in which the most powerful geysers are found.

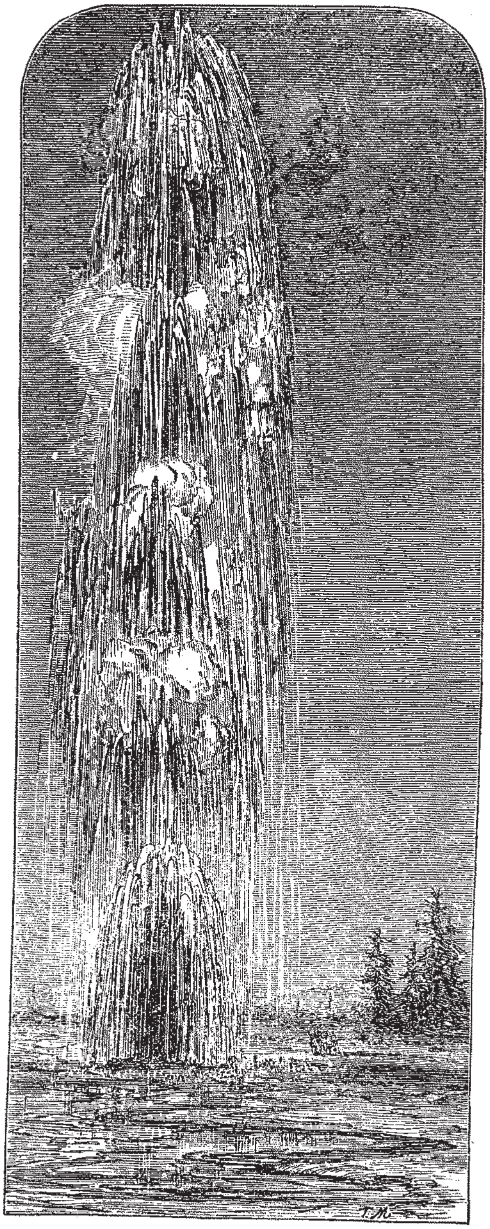

FIG. 7.—Giant Geyser.

The entire valley of the Firehole, averaging about three miles in width, is covered with siliceous crust as white as snow. The elevated mounds and numerous columns of steam reveal where the most important groups of springs and vents are located. In the Lower Geyser Basin, though there are many groups of most interesting springs, none of them can rank as geysers of the first class. Over an area of about three miles there must be at least a thousand active, quiet, dead and dying springs. One of the most remarkable of the springs in this lower basin has built up for itself a cistern, which is so elaborately beautiful that Mr. Hayden calls it the *architectural* fountain (Fig. 5). The whole basin is about 150 ft. in diameter. Near the centre is the rim of the spring, which is about 25 ft. in diameter; the water is in constant agitation, occasionally spouting up a column of water like an artificial fountain, and filling up the reservoir and the sides for a radius of 50 ft. or more. The siliceous accumulation made by this spring descends for several hundred feet in innumerable semicircular steps varying from one-fourth of an inch to two inches in height, and is exquisitely beautiful in all its details. When in active operation, a column of water is thrown 30 ft. to 60 ft. high, the water spreading over a radius of 50 ft., and filling the numerous reservoirs that surround the immense rim of the basin. There are other funnel-shaped basins with elegantly-scalloped rims, covered all over the inner side to the depth of 10 ft. to 20 ft. with bead-like tubercles of silica. Sometimes these siliceous beads are arranged in large numbers like fungi or corals, or like the heads of cauliflowers.

A short distance from this beautiful geyser is a remarkable group of *mud springs*. One of them has a basin 50 ft. in diameter, which is covered over thickly with puffs, like an immense cauldron of thick hasty-pudding (Fig. 6.) The exact symmetry of these puffs, their uniformity of size, and the fineness of the material, render them exceedingly beautiful; and there is among them every shade of colour from a bright scarlet to the most delicate pink or rose, with a base as white as snow. The most fastidious manufacturer of porcelain would go into ecstacies over this magnificent bed of mortar, that has, perhaps, been worked and re-worked for many thousands of years.

These springs occur in small groups all over the basin, and are often in close proximity to geysers or to perfectly quiet springs. They are found in every stage, from simply turbid water, through all grades of consistency, to thick stiff mud, through which the gases force themselves with a suppressed thud-like sound. Each of these mud springs probably commenced as a geyser, or at least a boiling spring. The water is at first clear, then becomes turbid, and grows gradually thicker, until the heat dies out.

The Upper Geyser Basin is located very near the source of the Firehole River, and between it and the Lower Geyser Basin there is an interval of about five miles, in which the hills come close to the river on both sides, and the springs occur only in small groups. Near the centre of the upper basin, which is about two miles long and half a mile wide, there is one of the most powerful geysers of the basin (Fig. 7). The preliminary warning is indicated by a tremendous rumbling, which shakes the ground all round with a sound like distant thunder; then an immense mass of steam bursts out of the crater as from an escape-pipe, followed by a column of water 8 ft. in diameter, and rising by steady impulses to the height of 200 ft. Mr. Hayden compares the noise and excitement it produced to that of a battle charge. He says the fountain continued to play for the space of fifteen minutes, when the water gradually subsided, and settled down in the crater about 2 ft., and the temperature slowly diminished to 150°. There are here two separate basins, one of which is in a constant state of violent agitation, while the other plays only at intervals of thirty-two hours; and although, so far as the eye can detect, there is a partition of not more than 2 ft. in thickness between them, neither of them seems to be affected by the operation of the other. The decorations about these springs are beyond conception beautiful; the most delicate embroidery could not rival them in their wonderful variety and complexity. The surface within and without is covered over with little tubercles of silica, which have a smooth, enamelled appearance like the most delicate pearls; down on the sides of the basin are large rounded masses like corals, formed entirely of silica. There are probably from twenty to fifty geysers of greater or less importance in this valley.

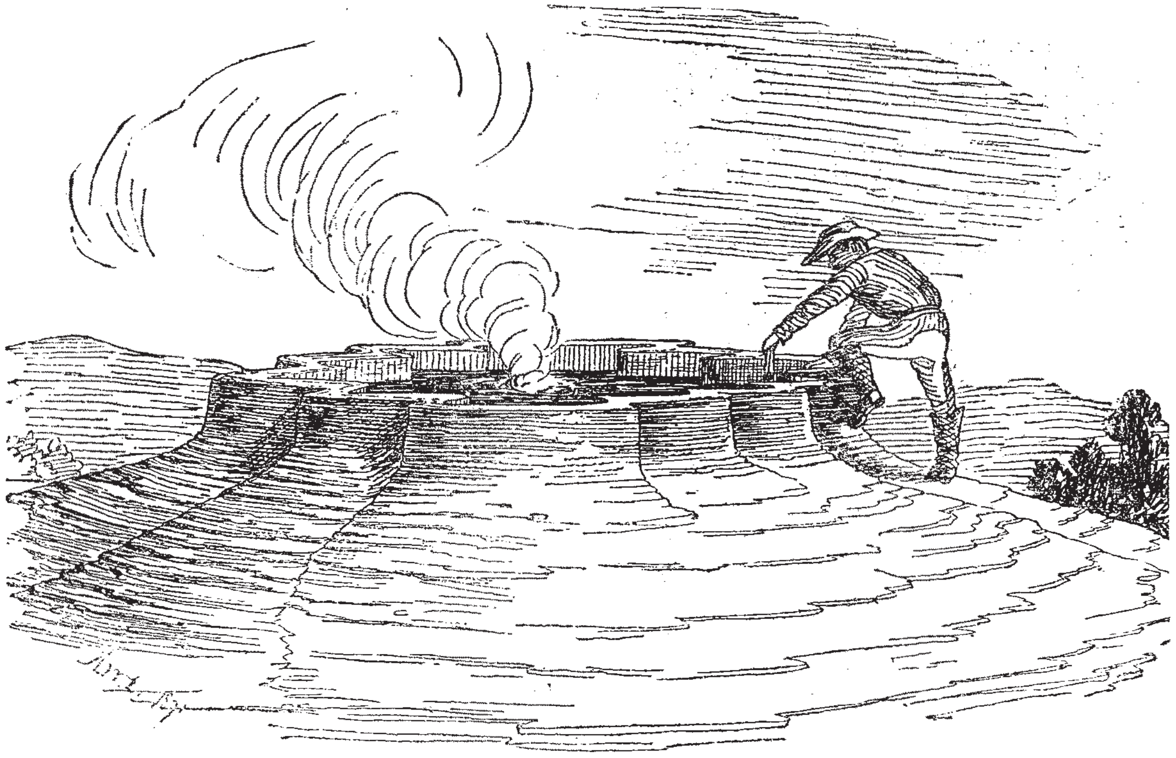

FIG. 8.—White Mountain Springs.

The two kinds of deposits in these regions, the calcareous and siliceous, have been mentioned in the preceding description. According to analysis by Dr. Peale, Chemist of the U. S. Geological Survey, the springs on Gardener's River, known as the White Mountain Springs (Fig. 8), deposit carbonate of lime mostly. There is present also sulphate of magnesia, chloride of calcium, sulphate of soda, and a little silica. In the deposits of the Firehole Basin not a trace of lime could be detected, but about 85 per cent. of silica, 11 per cent. of water, and the remainder mostly chloride of magnesium, and only a slight trace of lime has been found in the water. There are, scattered over the great area, a few patches of the sedimentary rocks, and it is most probable that underneath the deposit of this small group of springs there are portions of the carboniferous limestone.

So far as Mr. Hayden and party could ascertain, in all the deposits of the Yellowstone Basin proper, and the Firehole Basin, silica is the dominant constituent. The springs are, with very few exceptions, near the borders of the streams below beds of limestone. It is possible that underneath the vast masses of volcanic material which compose the mountains on every side, the sedimentary rocks exist; but Mr. Hayden is disposed to believe that they occur only in isolated and much restricted patches, if at all.

It may therefore be stated, in general terms, that the great hot-spring region of the Yellowstone and Missouri rivers is covered with rocks of volcanic origin, of comparatively modern date.

NOTES

AT their Statutory Quarterly Meeting on Monday, the Trustees of Anderson's University, Glasgow, elected Mr. George Forbes, B.A., F.R.S.E., of St. Catherine's College, Cambridge, to the vacant professorship of Natural Philosophy. There were originally eleven candidates for the appointment, but one of them died before the day of election arrived. Prof. Forbes is by inheritance, as well as by inclination and education, a man of science. The son of the late Principal, James D. Forbes, F.R.S., of St. Andrews, he received his university training at St. Andrews, Edinburgh, and Cambridge, and has since had the benefit of practical training in physical science at the Royal Observatory under the Astronomer Royal, and on the Continent. In making the appointment, the Andersonian trustees acted on the advice of Sir Wm. Thomson, Sir G. Biddell Airy, K.C.B.; Prof. P. G. Tait, Edinburgh; Prof. Balfour Stewart, Prof. A. S. Herschel, Profs. W. H. Miller and J. C. Adams, Cambridge; Prof. Grant, Glasgow Observatory, and other eminent physicists. It is understood that this professorship is to be established on a more extensive basis than formerly. This would offer to the professor a wider field of useful employment by developing the resources of the professorship, not only through the extension of the system of lecturing, but also by the establishment of a physical laboratory for students, which, it is understood, is in contemplation. Mr. Alexander Lindsay, of Glasgow, has also been elected Professor of Medical Jurisprudence. It was intimated to the meeting that Mr. J. Tennant, of Rollox, has given a donation of 1,000*l.* to the University.

THE following lectures on subjects connected with Physical and Medical Science will be delivered at the University of Cam-